METHOD AND SYSTEM FOR POST-TREATING DRY-ETCHED METAL FILM

FIELD OF THE INVENTION

[0001] The present invention relates to a method for post-treating a metal film, and more particularly to a method for post-treating a dry-etched metal film. The present invention also relates to a system for etching and post-treating a metal film.

BACKGROUND OF THE INVENTION

[0002] Metal films, for example aluminum-based films, are widely used in the production of electronic devices. When applied to liquid crystal displays (LCDs), the aluminum-based films are generally employed as conductive metal lines or reflective metal layers. Such aluminum-based films are also advantageous for other electronic products, as are well known in the art and are described in detail herein.

[0003] For producing conductive traces in a semiconductor manufacturing process, for example, an aluminum-based film made of aluminum or aluminum alloy is first formed on a substrate with previously formed elements thereon, and then subjected to an etching procedure to remove undefined portion thereof. Thus, a desired pattern of the conductive traces is formed by the remaining metal film. The etch procedure is generally divided into two types: dry etch and wet etch procedures. The wet etch procedure is performed by using an etchant solution to etch off the undesired portion of the aluminum-based film. Whereas, the dry etch procedure utilizes plasma resulting from exciting one or more reactive gas such as chlorine (Cl_2) or chlorine-containing gases such as boron

chloride (BCl_3) to physically or chemically etch off the undesired portion of the aluminum-based film.

[0004] For a dry etch procedure of an aluminum-based film, since the aluminum-based film is etched in the presence of a chlorine-containing etchant gas, chlorine radicals are likely to attack the aluminum-based film to form aluminum chloride ($AlCl_x$) on the film. It is known that aluminum chloride readily reacts with water to form soluble aluminum hydroxide $Al(OH)_x$, which is a main factor of resulting in corrosion of the aluminum-based film. In order to prevent the dry-etched film from corrosion during a period of waiting for next procedure (i.e. Q-time), one or more post treatments are required. These post treatments, for example, include carbon tetrafluoride/oxygen (CF_4/O_2) plasma treatment, gaseous water/oxygen ($H_2O(g)/O_2$) plasma treatment, hydrocarbonfluoride ($C_xH_yF_2$) deposition plasma treatment, ashing treatment and/or hot water rinse treatment, which are well known to a person skilled in the art. Although the above described post-treatments could somewhat overcome the problem of film corrosion, there still exist some drawbacks. For example, these post-treatments are troublesome and time-consuming, or might deteriorate the film.

SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide a method for post-treating a dry-etched metal film so as to prevent the film from corrosion.

[0006] It is an object of the present invention to provide a method for post-treating a dry-etched metal film, in which the treating period are largely reduced, so as to minimize the risk of film corrosion and increase throughput of manufacturing the metal film.

[0007] Another object of the present invention is to provide a system for performing combined etching and stripping procedures of a metal film so as to reduce overall operating time and minimize the risk of film corrosion.

[0008] In accordance with an aspect of the present invention, there is provided a method for post-treating a dry-etched metal film. The dry-etched metal film comprises an unetched portion covered by a photoresist and an etched portion exposed from the photoresist and having thereon an etching by-product. According to the method, a stripping agent is used to remove the photoresist on the unetched portion, while reacting the stripping agent with the etching by-product to form a passivation layer on the exposed metal film. Then, a washing agent is used to remove the passivation layer after the photoresist is removed.

[0009] In an embodiment, the metal film is an aluminum-based film. In particular, the aluminum-based film is made of a material selected from one of aluminum and aluminum alloy. The etching by-product is aluminum chloride ($AlCl_x$).

[0010] Preferably, the passivation layer is substantially non-reactive to water.

[0011] Preferably, the stripping agent is monoethanolamine (MEA), and the washing agent is isopropyl alcohol (IPA), water or a combination thereof.

[0012] Preferably, the method of the present invention is substantially performed immediately after the dry-etched metal film is formed.

[0013] In an embodiment, the method of the present invention further comprising a primary treatment step before the step of the stripping step, wherein the primary treatment step is selected from a group consisting of carbon tetrafluoride/oxygen (CF_4/O_2) plasma treatment, gaseous water/oxygen

($H_2O(g)/O_2$) plasma treatment, hydrocarbonfluoride ($C_xH_yF_2$) deposition plasma treatment, ashing treatment and hot water rinse treatment.

[0014] In accordance with another aspect of the present invention, there is provided a method for dry etching a metal film. A substrate with a metal film is provided thereon, wherein the metal film has a first portion covered by a photoresist and a second portion uncovered by the photoresist. Then, a dry etchant is used to etch off the second portion. Then, a stripping agent is used to remove the photoresist on the first portion and simultaneously form a water-insoluble passivation layer on a third portion of the etched metal film exposed from the photoresist. Then, a washing agent is used to wash off the water-insoluble passivation layer after the photoresist is removed.

[0015] In accordance with another aspect of the present invention, there is provided a system for performing combined etching and stripping procedures of a metal film. The system comprises at least one dry-etching chambers, at least one stripping and cleaning chambers and a transportation device. In the at least one dry-etching chambers, a substrate with a metal film is dry etched to form an unetched portion covered by a photoresist and an etched portion exposed from the photoresist. In the at least one stripping and cleaning chambers, the photoresist on the unetched portion is removed by a stripping agent and a passivation layer is formed on the etched portion by reacting the stripping agent. And in the transportation device transferring, the substrate between the at least one dry-etching chambers and the at least one stripping and cleaning chambers.

[0016] In an embodiment, each of the at least one stripping and cleaning chambers comprises a spin stripper.

[0017] In an embodiment, the system of the present invention comprises a load lock chamber and a transfer chamber between the at least one dry-etching

chambers and the at least one stripping and cleaning chambers, and the transportation device transferring the substrate between the at least one dry-etching chambers and the at least one stripping and cleaning chambers through the load lock chamber and a transfer chamber.

[0018] The above objects and advantages of the present invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Fig. 1 is a schematic diagram illustrating a system for performing etching and stripping procedures of a metal film according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] As described above, in a dry etch procedure of a metal film, the undesirable corrosion is possibly rendered by soluble hydroxides that are formed by the reaction of the metal with chlorine radicals derived from the etchant gas and the formation of further with ambient water vapor. In order to minimize corrosion during the dry etch procedure, it is believed to be a good way to form a water-insoluble metal compound as a passivation layer on the exposed metal film. A post-treatment method is used to achieve the purpose according to the present invention, which will be described hereinafter.

[0021] Generally, after an etching procedure is performed, the substrate will be transferred to a spin stripper to remove the photoresist. For aluminum or aluminum alloy, monoethanolamine (MEA) or other basic compounds are often employed as a stripping agent to remove the photoresist. Surprisingly, the inventors found that such agents are suitable for forming a passivation layer on

the exposed metal film. For example, when MEA is applied, the following reaction takes place:

$$AlCl_x + H_2N\text{-}CH_2\text{-}CH_2\text{-}OH \rightarrow Al(:NH_2\text{-}CH_2\text{-}CH_2\text{-}OH)_x + x\text{-}Cl$$

The product $Al(:NH_2\text{-}CH_2\text{-}CH_2\text{-}OH)_x$, which is known as a water-insoluble compound, covers the exposed surface of the metal film as a passivation layer. Therefore, by performing a stripping procedure immediately after the dry etch procedure, MEA can be used as the post-treatment agent for the dry etch procedure and the stripping agent for the stripping procedure at the same time. After the photoresist is removed in the stripping procedure, isopropyl alcohol (IPA) or water in place of monoethanolamine (MEA) is used to wash the substrate and remove the water-insoluble passivation layer.

[0022] According to the present invention, the stripping procedure functions as the post-treatment operation of the dry etch procedure, and thus the conventional additional post treatment can be omitted. In addition, the tact time per substrate and the cycle time of the overall process are shortened. It is of course that the conventional post treatments might also be performed between the dry etch procedure and the photoresist stripping procedure so as to enhance the effect of preventing from corrosion. Comparing with the conventional process performed by separately performing a dry etch procedure, post-treatment procedure and stripping procedure, the combined post treatment and stripping procedure according to the present invention is much more time-saving so as to reduce possible damage due to long tack time.

[0023] Since corrosion of the aluminum-based film generally occurs within 30 min after the dry etch procedure, it is preferred to post treat the etched

metal film as soon as possible. The present invention provides a system to perform the etching, post-treatment and stripping procedures of a metal film.

[0024] An embodiment of such system will be illustrated in reference to Fig. 1. As shown in Fig. 1, the system comprises a cassette station 11, one or two spin strippers 12 and 13, a load lock chamber (LLC) 14, a transfer chamber (TC) 15, and three dry-etching chambers 16, 17 and 18. Alternatively, the numbers of spin strippers and dry-etching chambers can be varied depending on practical requirements. It is understood that the spin strippers and the dry-etching chambers are disposed in the same machine rather than in separate machines as in the prior art.

[0025] The arrows shown in Fig. 1 indicate movement directions of the substrates to be processed. The substrates to be etched are fed from the cassette station 11, and then transferred via the load lock chamber (LLC) 14 and the transfer chamber (TC) 15 into one of the dry-etching chambers 16, 17 and 18. For example, a substrate10 is transferred into the dry-etching chamber 17 to be etched. After being dry etched, the substrate10 is rejected from the dry-etching chamber, and immediately transferred into the spin stripper 12 via the transfer chamber (TC) 15, the load lock chamber (LLC) 14, the transferring arm of the cassette station 11. In the spin stripper, the photoresist on the unetched portion of the metal film is removed by a stripping agent such as monoethanolamine (MEA), and meanwhile a passivation layer is formed on the etched portion by reacting this stripping agent with the metal film. After the photoresist is removed, isopropyl alcohol (IPA) or water in place of monoethanolamine (MEA) is used to wash the substrate and remove the water-insoluble passivation layer. By means of this system, the corrosive problem of the metal film is overcome

without additional post treatment, and the cycle time of the overall process is reduced.

[0026] Take a Ti/Al/Ti metal film composed of 500Å (Ti)/ 6,000Å (Al)/ 500Å (Ti) for example. In the prior art, when three dry-etching chambers are used, the time periods for performing main etching procedure, post treatment and discharging procedure are 170 sec, 60 sec and 10 sec, respectively. Thus, the tact time per substrate to finish the dry etch procedure and the stripping procedure is 94 sec. In accordance with the present invention, the time period for performing the post treatment by means of monoethanolamine (MEA) or other basic compounds is decreased to 15 sec. That is to say, the tact time per substrate is only 79 sec, and thus about 15-20 seconds are saved for processing each substrate. Based on an 80% equipment utility rate, the throughput of overall process is increased from 22.06k/month to 26.24k/month. It is of course that the time period for performing the post treatment is dependent on user's requirements. In particular, the conventional post treatment could be omitted, and instead, stripping agents are directly used to remove the photoresist and form a passivation layer simultaneously.

[0027] As mentioned above, hot water rinse treatment is partially effective to prevent corrosion of the metal film after the dry etch procedure. Such water rinse treatment can be applied to the present invention after the photoresist is removed, and performs both corrosion prevention and cleaning effects.

[0028] Since the dry etching and stripping procedures of a metal film are carried out on the same machine, the entire process from dry-etching the metal film till removing the photoresist on the dry etched metal film can be accomplished during a short period. In brief, the cycle time can be reduced due

to the combined dry etching and stripping procedures performed in a single system according to the present invention.

[0029] While the invention has been described in terms of what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention needs not be limited to the disclosed embodiment. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims which are to be accorded with the broadest interpretation so as to encompass all such modifications and similar structures.